



ARCHAEOZOOLOGY OF THE NEAR EAST

VIII

Actes des huitièmes Rencontres internationales
d'Archéozoologie de l'Asie du Sud-Ouest et des régions adjacentes

Proceedings of the eighth international Symposium on the
Archaeozoology of southwestern Asia and adjacent areas

TOME I

edited by

Emmanuelle VILA, Lionel GOURICHON,

Alice M. CHOYKE, Hijlke BUITENHUIS

Aswa VIII

Lyon 28 juin-1^{er} juillet 2006

Lyon, June 28th-July 1st, 2006

Ouvrage publié avec la participation de la Région Rhône-Alpes et de l'UMR 5133,
Archéorient, Maison de l'Orient et de la Méditerranée

SOMMAIRE

Tome I

Emmanuelle VILA, Lionel GOURICHON	
Avant-Propos	13
Preface	17
François POPLIN	
<i>Prologue anthropozoologique – Animal vrai, sacrifice et domestication laitière</i>	21
<i>Anthropozoological prologue—True animal, sacrifice and the domestication of dairy animals</i>	33
Liora KOLSKA HORWITZ, Hitomi HONGO	
<i>Putting the meat back on old bones. A reassessment of Middle Palaeolithic fauna from Amud Cave (Israel)</i>	45
Hervé MONCHOT	
<i>Des hyènes tachetées au Pléistocène supérieur dans le Zagros (grotte Wezmeh, Iran)</i>	65
Anne BOUTEAUX, Anne-Marie MOIGNE, Kasman SETIAGAMA	
<i>Études archéozoologiques de sites javanais du Pléistocène : les sites de plein air du dôme de Sangiran (Java central) et le site en grotte de Song Terus (Java est)</i>	79
Anne BRIDAULT, Rivka RABINOVICH, Tal SIMMONS	
<i>Human activities, site location and taphonomic process: a relevant combination for understanding the fauna of Eynan (Ain Mallaha), level Ib (final Natufian, Israel)</i>	99
Daniel HELMER, Lionel GOURICHON	
<i>Premières données sur les modalités de subsistance à Tell Aswad (Syrie, PPNB moyen et récent, Néolithique céramique ancien) – Fouilles 2001-2005</i>	119
Maria SAÑA, Carlos TORNERO	
<i>Consumption of animal resources at the sites of Akarçay Tepe and Tell Halula (Middle Euphrates Valley, 8th-6th millennia cal. BC)</i>	153
Daniel HELMER	
<i>Révision de la faune de Cafer Höyük (Malatya, Turquie) : apports des méthodes de l'analyse des mélanges et de l'analyse de Kernel à la mise en évidence de la domestication</i>	169
Gisela GRUPE, Joris PETERS	
<i>Feeding humans and animals at Pre-Pottery Neolithic Nevalı Çori (SE-Anatolia) as evidenced by stable isotope analysis</i>	197

Francoise LE MORT, Jean-Denis VIGNE, Simon J.M. DAVIS, Jean GUILAINE, Alain LE BRUN <i>Man-animal relationships in the Pre-pottery burials at Shillourokambos and Khirokitia (Cyprus, 8th and 7th millennia cal. BC)</i>	219
Melinda A. ZEDER <i>Animal Domestication in the Zagros: an Update and Directions for Future Research</i>	243
Jean CANTUEL, Armelle GARDEISEN, Josette RENARD <i>L'exploitation de la faune durant le Néolithique dans le bassin égéen</i>	279
Hijlke BUITENHUIS <i>Ilıpınar: The faunal remains from the late Neolithic and early Chalcolithic levels</i>	299
Chiara CAVALLO, Tijmen MOESKER <i>Faunal remains from the Neolithic levels of Tell Sabi Abyad (Syria)</i>	323

Tome II

Benjamin S. ARBUCKLE	
<i>Caprine exploitation at Er Baba Höyük: A Pottery Neolithic village in Central Anatolia...</i>	345
Bea DE CUPERE, Refik DURU, Gülsün UMURTAĞ	
<i>Animal husbandry at the Early Neolithic to Early Bronze Age site of Bademağacı (Antalya province, SW Turkey): evidence from the faunal remains ...</i>	367
Polydora BAKER	
<i>Economy, environment and society at Kilise Tepe, Southern Central Turkey – Faunal remains from the 1994-1998 excavations ...</i>	407
Mohammed AL-ZAWAHRA	
<i>The faunal remains from Tell el-Majfer, a Chalcolithic site in the Lower Jordan Valley, Palestine ...</i>	431
Jennifer PIRO	
<i>Pastoral economies in Early Transcaucasian communities from the mid-4th to 3rd millennium BC. ...</i>	451
Margarethe UERPMANN, Hans-Peter UERPMANN	
<i>Animal economy during the Early Bronze Age in South-East Arabia ...</i>	465
Angela VON DEN DRIESCH, Helmut BRÜCKNER, Henriette OBERMAIER, Anja ZANDER	
<i>The hunt for wild dromedaries at the United Arab Emirates coast during the 3rd and 2nd millennia BC. Camel bones from the excavations at Al Sufouh 2, Dubai, UAE ...</i>	487
Jill A. WEBER	
<i>Elite equids: redefining equid burials of the mid- to late 3rd millennium BC from Umm el-Marra, Syria. ...</i>	499
Lilit MIRZOYAN, Nina MANASERYAN	
<i>Archaeozoological investigation of the site of Shirakavan, 3rd-1st millennia BC, Armenia ...</i>	521
Nina MANASERYAN	
<i>Réduction de la variété spécifique des vertébrés au cours de l'Holocène en Arménie ...</i>	533
Chiori KITAGAWA	
<i>The status of fallow deer in Ancient Egypt: autochthonous or introduced? ...</i>	541
Marco MASSETI	
<i>A zoomorphic gold figurine from the Late Bronze Age on the island of Thera (Santorini), Greece. ...</i>	553
Cornelia BECKER	
<i>The faunal remains from Dur-Katlimmu—Insights into the diet of the Assyrians ...</i>	561

Jacqueline STUDER, Annegret SCHNEIDER

Camel use in the Petra region, Jordan: 1st century BC to 4th century AD. 581

Yves LIGNEREUX, Henriette OBERMAIER, Simon SCHNEIDER

Les restes animaux du Palais d'Amathonte à Chypre, à l'époque classique (V^e et IV^e siècles av. J.-C.) 597

Tarek OUESLATI

Spatial fluctuation of food habits in Byzantine Beirut (Bey 002, Bey 028, Bey 115) 629

HUMAN ACTIVITIES, SITE LOCATION AND TAPHONOMIC PROCESS: A RELEVANT COMBINATION FOR UNDERSTANDING THE FAUNA OF EYNAN (AIN MALLAHA), LEVEL IB (FINAL NATUFIAN, ISRAEL)

Anne BRIDAULT¹, Rivka RABINOVICH², Tal SIMMONS³

ABSTRACT

Recent excavations conducted by F. Valla and H. Khalaily at Eynan/Ain Mallaha, located in the Upper Jordan Valley, have since 1996, concentrated on the Final Natufian layer. Numerous faunal remains were collected from the occupation floors of the features and from structures, from the stony layer. An analysis of several samples from the upper layer is presented here. General questions regarding the nature of the Natufian economy, the modes of occupation and the habitats exploited by these people have been addressed. A detailed presentation of the material has also been provided and the frequencies of species discussed. Finally, we have tried to reconstruct the origin of the fauna, its characteristics and its impact on the human inhabitants of Eynan.

Keywords: Zooarchaeology, broad spectrum, subsistence, Final Natufian, Near East, Israel.

RÉSUMÉ

Les fouilles conduites depuis 1996 par F. Valla and H. Khalaily sur le site d'Eynan (Ain Mallaha) dans le nord de Vallée du Jourdain se sont concentrées sur le niveau natoufien final. Une faune très abondante a été recueillie tant sur les sols des structures construites que dans le cailloutis encaissant. Nous présentons ici une analyse de plusieurs échantillons provenant principalement de la partie supérieure de ce niveau (Ib1). Une présentation détaillée du matériel ainsi qu'une restitution des processus taphonomiques lisibles permettent de poser les potentialités et les limites interprétatives d'un tel matériel. L'analyse souligne les principales caractéristiques de cette faune interprétées en termes d'environnement et de comportements liés à l'exploitation des ressources. Replacée dans le contexte régional et chronologique, l'analyse met en

-
1. UMR 7041, Équipe « Archéologies environnementales », Maison de l'Archéologie et de l'Ethnologie, Nanterre, France, e-mail : anne.bridault@mae.u-paris10.fr
 2. Department of Evolution, Systematics and Ecology, The Hebrew University, Jerusalem, Israel, e-mail: rivka@vms.huji.ac.il
 3. Department of Forensic and Investigative Science, University of Central Lancashire, Preston, United Kingdom, e-mail: tlisimmons@uclan.ac.uk

évidence à la fois le poids de l'environnement local marqué par la présence de l'eau ainsi que certains traits de l'économie de subsistance partagés avec d'autres sites du Natoufien récent et final. La question d'un mode de vie sédentaire ou non est également discutée.

Mots-clés : Archéozoologie, diversité, subsistance, Natoufien final, Proche-Orient, Israël.

INTRODUCTION

Recent excavations conducted by F. Valla and H. Kallailly at Eynan/Ain Mallaha, located in the Upper Jordan Valley, have since 1996, concentrated on the Final Natufian layer. This archaeological culture is defined by lithic assemblages typified by small crescents that are present in sites with almost no built features (Valla 1988). Six sites, from the Middle Euphrates region to southern Jordan contain such assemblages (Valla 1988) (*fig. 1*). Until recently, many scholars agreed that the Final Natufian represented a return to a more mobile way of life (Boyd 2006). At Eynan, the Final Natufian layer represents a very dense stony layer embedded in a reddish-brown matrix; it is subdivided into lower (Ib2) and upper (Ib1) levels, corresponding to the main phases of building activities. The presence of numerous built structures calls into question the mobile nature of Natufian life at Eynan (Samuelian *et al.* 2006). The average date of the lower occupation is *ca* 10 500 BP (10 839-10 289 cal. BC, 2 σ), placing it during the Younger Dryas, the last major cooling and drying event (as revealed by several proxies) (Bar-Matthews *et al.* 1997; Gvirtzman, Wieder 2001), and some 2500-3000 years earlier than the appearance of agriculture.

There has been an endless debate regarding the nature of the Natufian, in which the analysis of Natufian fauna plays an important role. Several contentious issues include: 1. whether there is any kind of causal relationship between cultural events and environmental changes (*e.g.* Goring-Morris, Belfer-Cohen 1998; Tchernov 1998; Bar-Yosef, Belfer-Cohen 2002); 2. whether there was really a “broad spectrum revolution” (Flannery 1969; Tchernov 1993a) or not (Bar-Oz, Dayan 1999; Stiner *et al.* 1999; Stiner *et al.* 2000; Stiner 2001); 3. whether there is evidence for size change in certain animal species, especially gazelles, and whether it is related to selective culling (Horwitz *et al.* 1990; Cope 1991) or to environmental changes (Davis 1981, 1982).

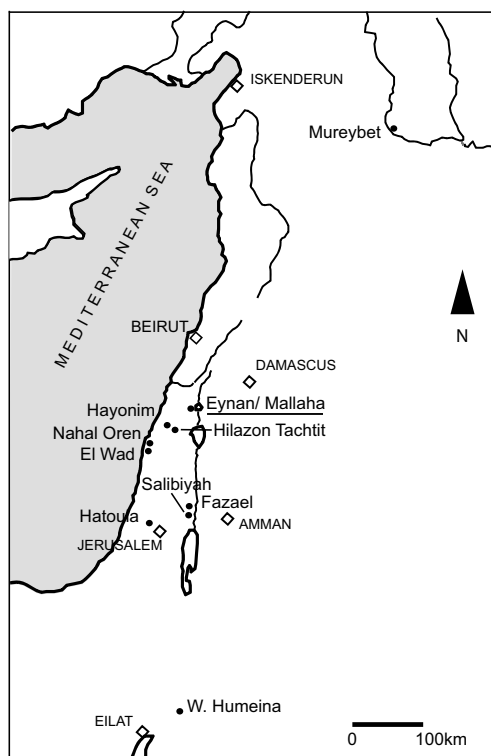


Fig. 1—Location of Eynan (Mallaha) and other Late and Final Natufian sites.

How can the fauna from Eynan contribute to these debates? Faunal remains from Eynan's excavations were very carefully collected and sorted, leading to the recovery of a large quantity of material, much of which is still being studied. Owing to the complexity of the site and to the sampling pattern, questions more generally addressed for each faunal sample, such as "what combination of factors can explain the observed faunal patterns", are particularly relevant here. Observations from ongoing research will be discussed in terms of environmental, chronologically contextual and taphonomic processes in order to elucidate a number of economic and cultural patterns.

FAUNAL SAMPLES IN THE SITE CONTEXT

Located at the foot of steep hills, the site of Eynan lies not far from the northwestern side of Lake Hula. Hula is the northernmost freshwater lake in the Jordan Basin (Dimentman *et al.* 1992). Until the 1950s a permanent spring and stream with water of stable temperature was located very close to the site. The site itself encompassed a great variety of environments (*ibid.*).

The Final Natufian level (Ib) is a very dense, calcareous stony layer, embedded in a reddish brownish matrix ranging from 0.50 to 1 m in thickness. The process of formation of the stony layer still remains unclear (Valla *et al.* 1999, 2001), although the layer is no longer thought to have been re-deposited as the result of a landslide event. Numerous built structures and floors have been identified within the stony layer. Some are interpreted as "shelters" or "huts", sharing similar characteristics with ones previously brought to light in earlier levels, although these are smaller in area ($< 10 \text{ m}^2$). These structures manifest as half buried in pits dug into the earth, with walls no higher than 0.50 m. They are associated with other, variable features (e.g. postholes, hearths, "basins") (Samuelian *et al.* 2006). Level Ib is subdivided into a lower (Ib2) and an upper (Ib1) level, corresponding to the main phases of building activities:

—The earliest phase, level Ib2, is capped with 0.20 m of sediment. It comprises one "hut" with associated features (hut 215). The faunal sample is currently being studied.

—The upper phase, level Ib1, includes four built structures (218, 200-208, 203 and 202).

Faunal assemblages originate from the upper floor of the 200, 203 and 222 structures (fig. 2). A third sample comes from the upper part of the stony layer, not from within the structures. The occupation of the structures was shorter than the occupation of the stony layer itself.

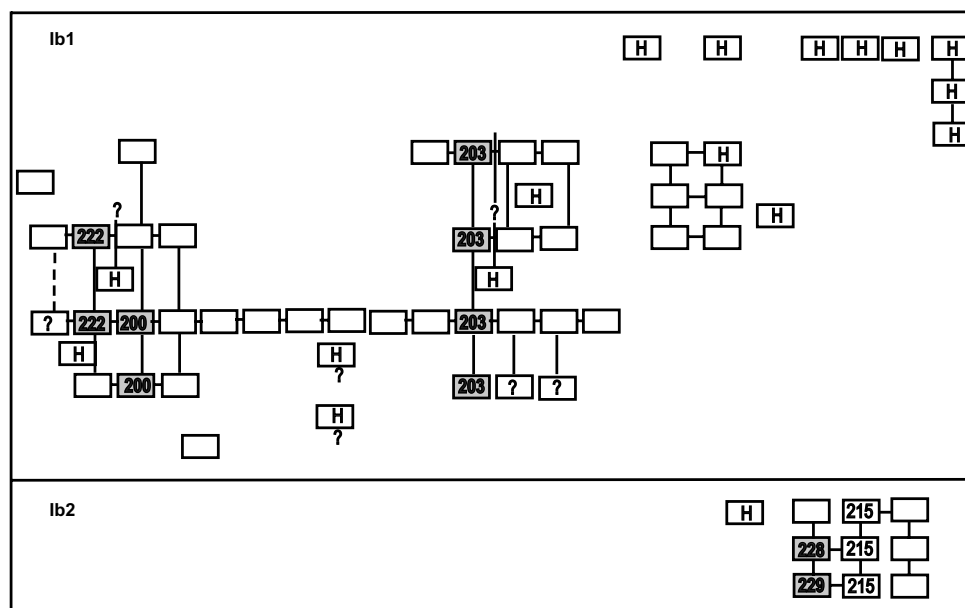


Fig. 2—Stratigraphy of level Ib. The shaded areas indicate the faunal samples that have already been studied. Another sample comes from the upper part of the stony layer but is not represented here (from row 93). It is designated the "stony layer sample" in the text. H = human remains (after Valla *et al.* 2004, p. 55).

REPRESENTATIVENESS, BIAS AND NATURE OF THE DATA IN RELATION TO THE FAUNAL MATERIAL

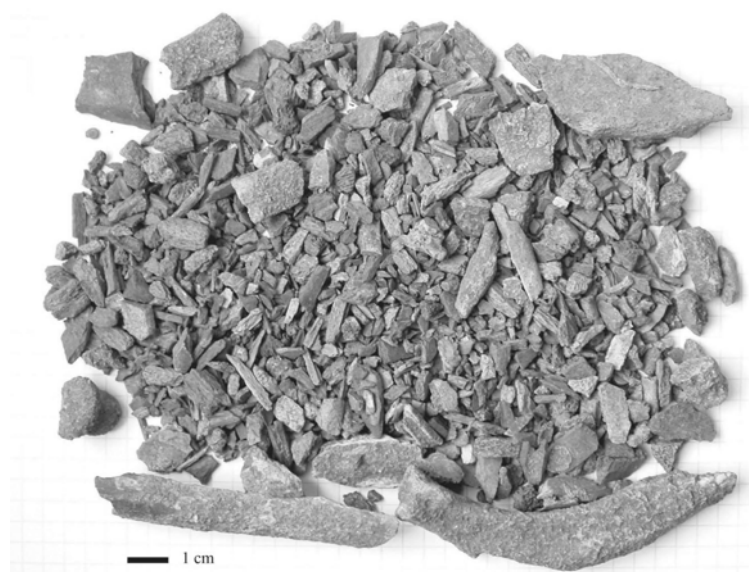
It is well established that recovery techniques can influence the quality of the samples and their representativeness both in terms of number of species present and body part representation (Payne 1975; Clason, Prummel 1977). The painstaking recovery techniques—controlled, excavation within $\frac{1}{4} \text{ m}^2$ boundaries, systematic fine water-sieving (2 mm) and exhaustive sorting of the sieved material—conducted at this site, eliminate this type of bias. The methodology employed consequently guarantees that the faunal sample will reflect taxonomic richness and diversity. Nonetheless, some characteristics of the material together with an indication of the deposition process, suggest a possible source of bias:

—The high degree of fragmentation results in a low percentage of identification to the species level in the assemblages from both the stony layer and the structures. The majority of the fragments are 1 cm in length and below while the remainder are 1-2 cm long with a very low proportion of fragments measuring 5-10 cm in any dimension (*fig. 3, 4*). The large quantity of long bone splinters might have resulted in part from pre-depositional fracturing, as suggested from some tiny fragments with very fresh fracture edges (*fig. 5*). These fragments may have become detached during fracturing when the bones were fresh. Clear signs of intense fragmentation are rare since the bones are too broken-up to conserve signs of it. As skeletal fragmentation affects all taxonomic groups, post-depositional *in situ* mechanical processes such as trampling and crushing in sediments are assumed, although they are difficult to quantify here (cf. *in situ* attrition: Munro, Bar-Oz 2005).

—The faunal remains are thickly covered with an encrustation that seems related to not yet understood taphonomic processes. Large fragments ($> 1.5 \text{ cm}$ in length) tend to be systematically encrusted all around, together with some fragments of chelonian carapace and bones from the microfauna and avifauna. The smallest elements are more often covered with a thin, easily removed layer. This difference suggests two possible scenarios of accumulation:

- * Different taphonomical processes are responsible for the accumulation of smaller animals/elements than the larger ones (animals the size of hare and larger).

- * Sediment deposition on the outer surface of the bones is size-dependent and a certain surface size is required in order for accumulation to take place, thus, leaving the smaller bones cleaner.



*Fig. 3—Eynan Ib: A faunal sample from a $\frac{1}{4} \text{ m}^2$ stony layer, before being sorted.
Note the encrustation on the bones (photo A. Bridault).*



Fig. 4—Eynan Ib: A faunal sample from a $\frac{1}{4}$ m² stony layer, during sorting for identification (photo A. Bridault).

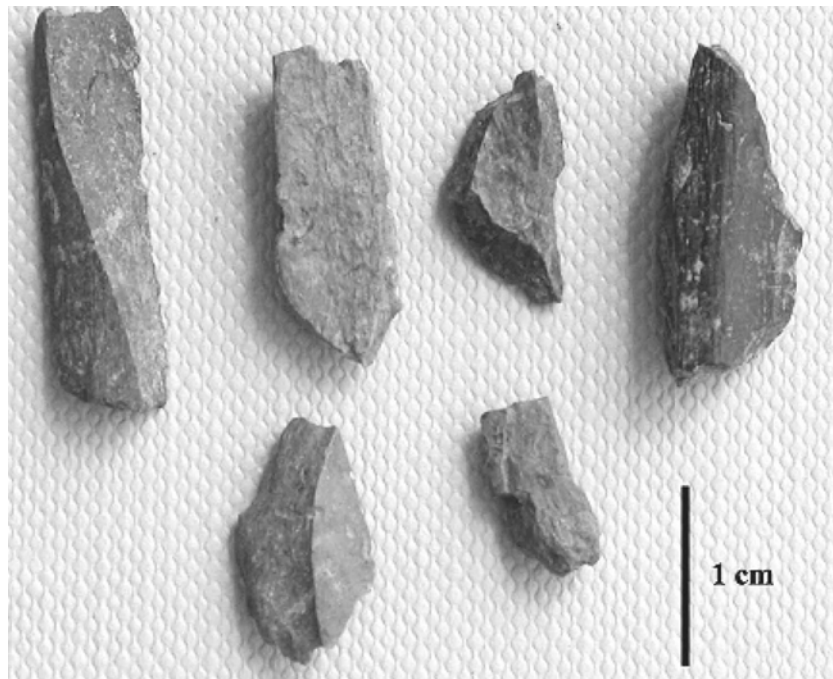


Fig. 5—Eynan Ib: Small splinters from long bones with fresh fracture edges (photo A. Bridault).

It is possible that a post-depositional alteration of a chemical nature played a role in the taphonomic process. Micromorphological analyses conducted on structure 201 (L99) and the upper “sol” of structure 203 signal the presence of neo-carbonates in the sediment samples indicating leaching of the living floor after its abandonment (March *in* Valla *et al.* 2001). The modest evidence for weathering cracks, the numerous

fresh fracture edges (cf. *supra*) and the evidence of fossilized and encrusted carpals found connected anatomically (fig. 6) all suggest that the bones were exposed for only a short time before the encrustation process got underway.

The general low proportion of fragmented dental remains (17% of the mammalian remains in the stony layer assemblage) is a characteristic to be underscored as a reverse pattern generally observed in poorly preserved or damaged samples (Binford 1981; Brain 1981). Consequently, it may be linked to patterned behavior (e.g. discarding the heads of hunted animals) rather than taphonomic bias.

Considered together, these characteristics indicate that few elements providing data for age estimation and metrics were available. Moreover, many faunal fragments could not be identified either to the species level, skeletal element or even body size group.

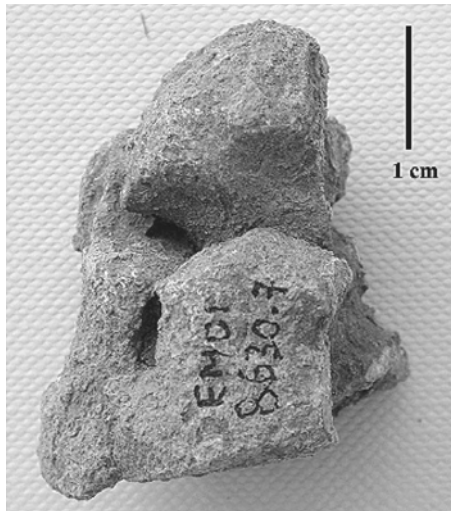


Fig. 6—Eynan Ib: Fallow deer carpal bones connected anatomically (photo A. Bridault).

EVIDENCE OF BUTCHERING AND MANUFACTURING ACTIVITIES

Very few cut marks (fig. 7) were observed on the larger identifiable elements, although it was sometimes possible to observe some marks on smaller fragments or on pieces cleaned with acid. Therefore, reconstruction how carcasses were processed is difficult. Nonetheless, the identification of the type of marks, their interpretation based on cut mark patterns and their locations, leads to the conclusion that different sequences of carcasses processing and treatment related to butchery, consumption activities and bone manufacturing (Le Dosseur *in* Valla *et al.* 2004) are represented in the assemblages (table 1).

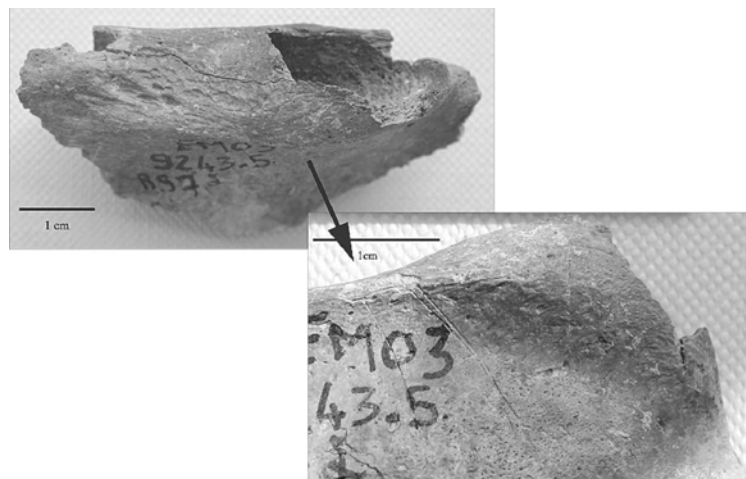


Fig. 7—Eynan Ib: Wild boar mandible fragment with cut marks near the canine alveolar (photo A. Bridault).

Type of marks/activity	Species	Bone fragment	Purpose
Skinning	Marten, wild boar	Mandible (horizontal ramus), cranium, pubis.	Fur procurement/ Butchery
Skinning? Canine removal?	Wild boar	Mandible (near the canine socket)	
Filleting	Fallow deer	Scapula	Butchery
	Gazelle/roe deer	Humerus	
Scraping	Fallow deer	Humerus	Butchery and/ or bone tool manufacturing?
	Unidentified	Fragment of long bone	
Breakage by flexure?	Cervid	Antler	Bone tool manufacturing

**—line 93 pro parte—1998 excavation

^—many incisors

Table 1—Type of marks identified.

A BROAD SPECTRUM DIET

In order to provide a realistic idea of the taxonomic richness that characterizes the Eynan fauna, it is important to mention the various taxa represented: mammals (11 species), micromammals (various species including squirrel), birds (17 species), chelonia (1 species), reptiles, amphibians, crustaceans (1 crab species, *Potamon* sp.), fish (very abundant remains), and molluscs (fresh and saltwater species). These are all under study by different specialists. Such an assemblage can be considered to reflect a “broad spectrum” pattern of exploitation (Flannery 1969).

In order to summarize the composition of the studied material, and taking into account the incompleteness of the faunal elements, it is useful to count NISP's of different taxa. The resulting pattern is that 80% of the identified specimens (micromammals, fish and molluscs remains excluded), from level Ib1 are chelonian in origin (cf. *Testudo graeca*) remains, 9% derive from macro-mammals, 5% from birds, nearly 3% from reptiles, 1.6% from amphibians and 0.7% from crustaceans (fig. 8). Chelonian parts are mainly carapace and plastron fragments, while limb remains are scarce (fig. 9). Chelonia were present in every studied area (structures and stony layer) and a significant proportion of the elements was burnt. In most cases the bony plates are as small as 0.5 mm, with the majority up to 5 mm in size (Rabinovich *in* Valla *et al.* 2001a, fig. 42). Although the chelonian remains outnumber the other assemblages for NISP, they represent, on average, only 7% of the total weight of the bones in the stony layer sample. This distribution suggests that few individuals are, in fact, represented in each assemblage since the carapace of an individual measures between 100-250 mm in length and *ca* 150 mm in breadth. The status of this animal in the Eynan assemblage needs further elucidation. It is likely that only a few individuals contributed to the assemblage,

but that these were highly fragmented. The size of the carapace pieces either suggests intensive human processing or depositional processes that caused this phenomenon. The level of fragmentation may also be related to the human collecting of young tortoises, which have a relatively fragile carapace.

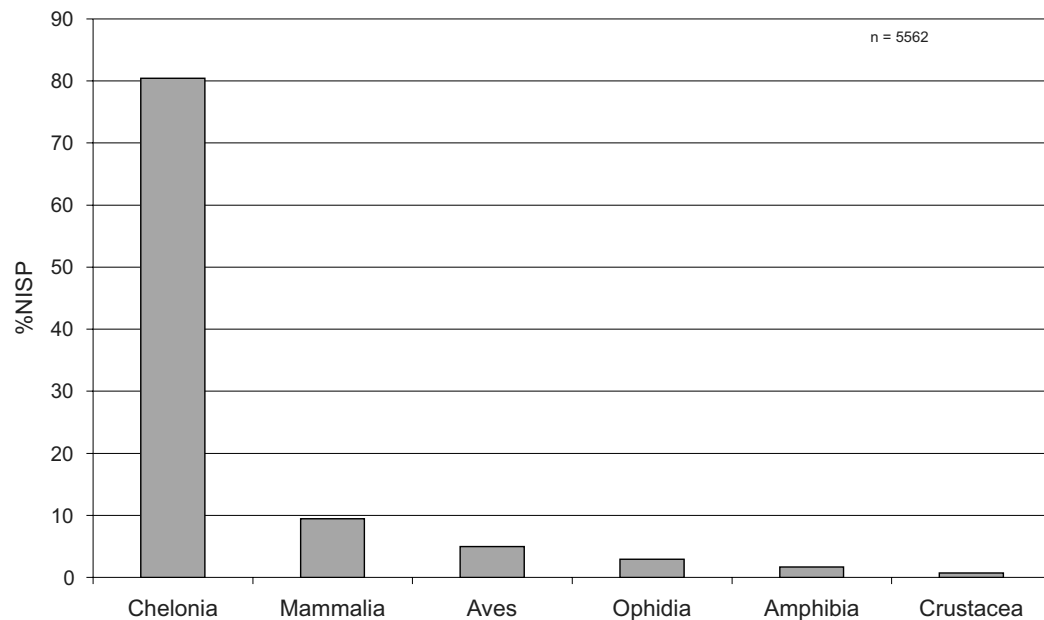


Fig. 8—Relative frequencies of main taxonomic groups (micromammals, fishes, molluscs excluded) for level Ib1.



Fig. 9—Eynan Ib: Chelonia remains (photo A. Bridault).

UNGULATE DISTRIBUTION AND COMPARISONS

Mountain gazelle (*Gazella gazella*) is the most common species among the ungulates in all samples when counted by NISP (33-36% of the NISP, cf. table 2; and ca 47 % of the ungulates remains, fig. 10), although it is represented by only a few individuals. The relative frequency of gazelle remains is nonetheless certainly underestimated considering the high proportion of the *Gazella/Capreolus* body size group (BSGD) fragments and the few roe deer remains identified in the assemblage (table 2, fig. 11).

Species		Stony layer **		STR 200		STR 222	STR 203	
		NISP	%	NISP	%	NISP	NISP	%
<i>Gazella gazella</i>	Mountain Gazelle	66	32.84	60	34.29	2	47	35.88
<i>Dama mesopotamica</i>	Fallow deer	31	15.42	15	8.57		10	7.63
<i>Cervus elaphus</i>	Red deer	1	0.50	1	0.57			
<i>Capreolus capreolus</i>	Roe deer	9	4.48	2	1.14		11	8.40
<i>Cervidae</i>	Cervid unident.	9	4.48	11	6.29	5	8	6.11
<i>Sus scrofa</i>	Wild boar	21	10.45	40	22.86	4	23	17.56
<i>Canis sp.</i>	Wolf / dog	2	1.00	2	1.14			
<i>Vulpes vulpes</i>	Red fox	20	9.95	2	1.14	1	6	4.58
<i>Felis sp.</i>	Felid			1	0.57		2	1.53
<i>Martes cf. foina</i>	Stone marten	2	1.00					
<i>Carnivora</i>	Carniv. Unident.	2	1.00	5	2.86	1		
<i>Lepus capensis</i>	Hare	38	18.91	36	20.57	4	24	18.32
Total 1		201	100.00	175	100.00	17	131	100.00
Body size group (>250 kg)		1	1.06	5	1.36	0	0	0.00
Body size group (80-250 kg)		21	22.34	46	12.53	3	33	17.01
Body size group (15-40 kg)		52	55.32	260	70.84	21	129	66.49
Body size group (<15 kg)		20	21.28	56	15.26	3	32	16.49
Total 2		94	100.00	367	100.00	27	194	100.00
Microfauna and insectivores		present		ca 50^				
<i>Sciurus anomalus</i>	Squirrel	2						

Table 2—Species abundance of the main species and taxa (fishes and molluscs excluded) represented in the assemblages from level Ib (Final Natufian).

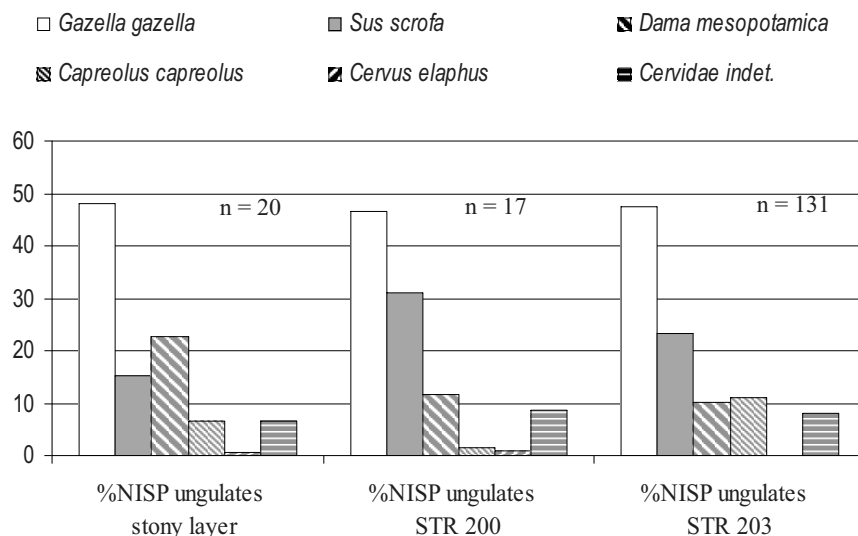


Fig. 10—Relative frequencies of the ungulates species in three assemblages from level Ib1.

Wild boar (*Sus scrofa*) is the next most common species to be represented in the structures (18% and 23% of the NISP), whereas hare (*Lepus capensis*) is the second most common species in the stony layer sample (ca 19% NISP). Suid remains appear to be significantly more abundant in structure 200 than in the stony layer based on a comparison of NISP percentages. Persian fallow deer (*Dama mesopotamica*) comes in the third, accounting for 8 to 15% of the NISP. These frequencies are not significantly different, relative to sample size.

In spite of the paucity of roe deer and red deer remains, the three cervid species are represented in both the stony layer as well as in structure 200. The unidentified cervid category includes antler, teeth and bone fragments that could not be assigned to the exact species level.

There are no marked differences in mammalian species distribution between the samples. The only apparent difference between the stony layer and the structures emerges in the *Gazella/Capreolus* body size group (BSGD), where the long bone splinters (longitudinally broken bones) are more abundant in the structures.

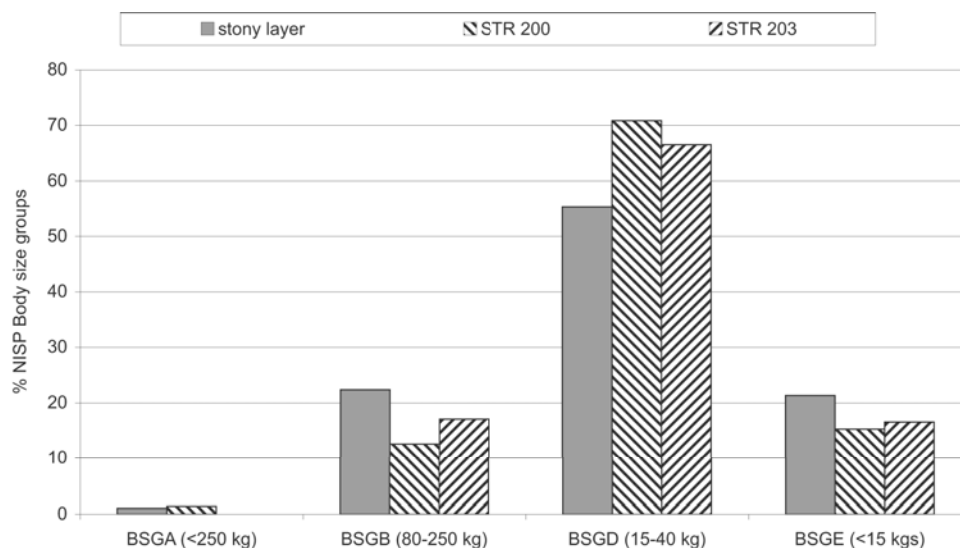


Fig. 11—Relative frequencies of the Body Size Groups specimens in three assemblages from level Ib1.

The general distribution pattern of the medium size mammalian skeletal units shows that frequencies of head elements (mainly small tooth fragments) and long bone splinters outnumber other body part categories (Rabinovich, Bridault *in* Valla *et al.* 2004). Considered together with the limited number of limb bone remains, these numbers may represent intentional bone breakage for marrow extraction. Post-cranial axial elements (vertebrae, ribs) as well as scapula and pelvis are underrepresented. Using NISP as a measure favors the representation of the fragmented long bones, but this is also true when other indices are used (*e.g.* in Mesolithic French sites, Bridault, Chaix 1998). Such patterns are common, corresponding to selective transport and/or differential discard behavior. Here, it is assumed that natural attrition and selective discard may be responsible for this pattern.

Although gazelle is the most common species in the Eynan final Natufian samples, it is not dominant. Even if we include the relative body size (*i.e.* BSGD with gazelle), thus, increasing the proportion of gazelle in the assemblage, it is still less abundant (average = 60% based on Ducos' method; Ducos 1973) than at most Late Natufian assemblages, where gazelle bones can represent more than 80% of the ungulates remains (*fig. 12*). At Final Natufian Mureybet Q34 B4, Q32 E2 (Helmer 1991), located to the north of this site, gazelle accounts for 65-68% of the ungulates remains; these proportions are similar to those of the Late Natufian samples from Eynan.

Conversely, Eynan's faunal assemblages are characterized by the highest proportion of wild boar when compared to other Late and Final Natufian assemblages in the region (*fig. 13*).

The relatively low proportion of gazelle and the high proportion of wild boar represent a pattern particular to the Eynan Final Natufian. This distribution may be a result of the unique location of the site near a sweet-cold permanent spring. Moreover, human processing and post-depositional processes that have resulted in serious fragmentation of skeletal elements are also responsible for this distribution pattern.

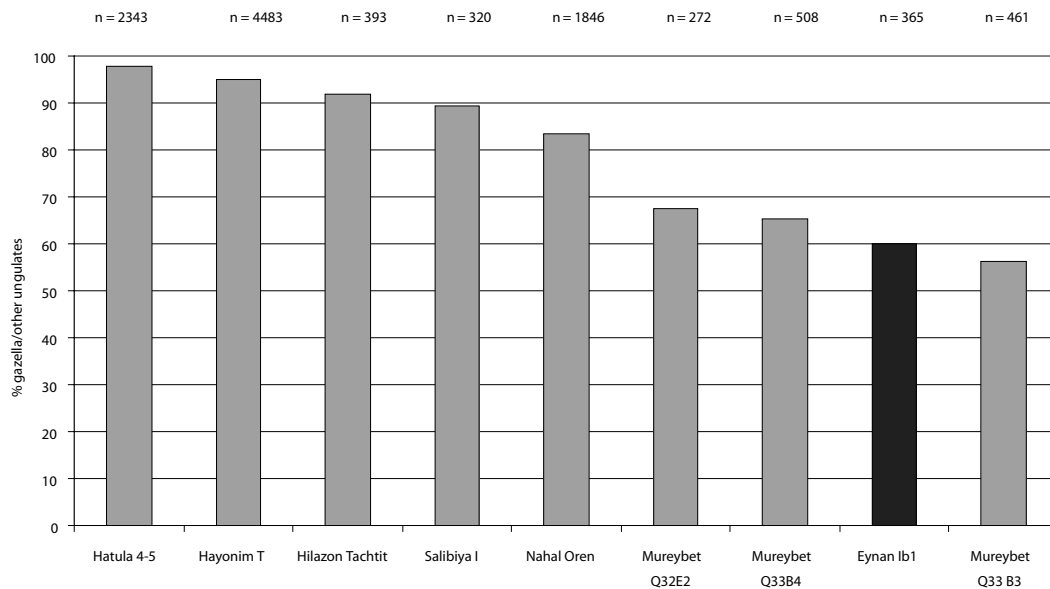


Fig. 12—Average adjusted frequency of gazelle (Gazella gazella) at Eynan Ib1 compared to frequencies of gazelle from other Late and Final Natufian assemblages. Data Hayonim Terrasse (Munro 2004); Hilazon Tachtit (Munro 2004); Mureybet (Helmer 1991); Salibiya I (Crabtree et al. 1991).

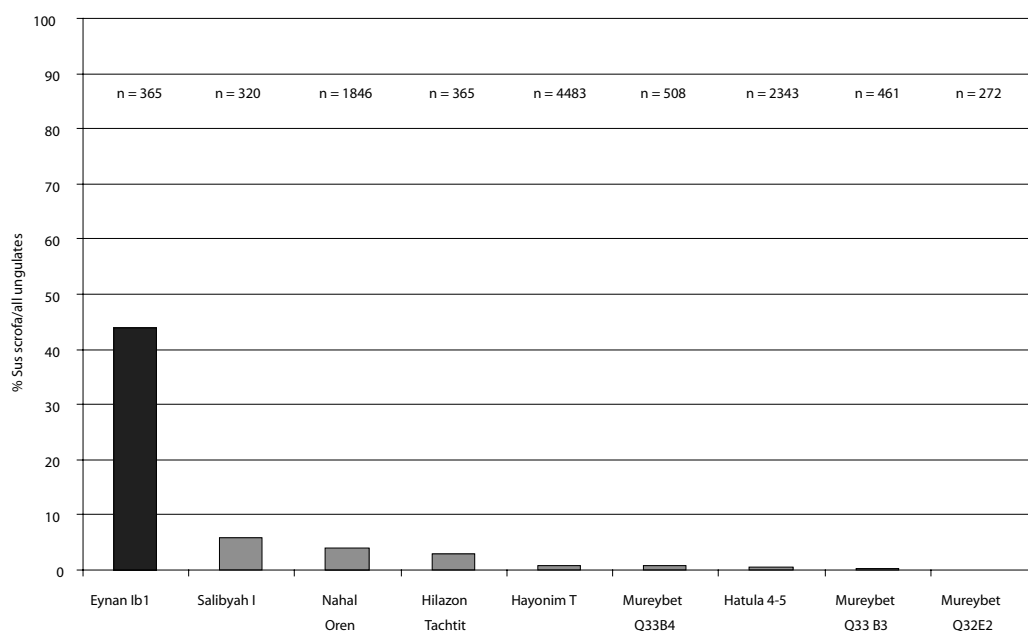


Fig. 13—Average frequency of wild boar (Sus scrofa scrofa) at Eynan Ib1 compared to frequencies of wild boar from other Late and Final Natufian assemblages. Data Hayonim Terrasse (Munro 2004); Hilazon Tachtit (Munro 2004); Mureybet (Helmer 1991); Salibiya I (Crabtree et al. 1991).

SMALL SIZE MAMMALIAN SPECIES DISTRIBUTION AND COMPARISONS

Canids (*Canis* sp. and *Vulpes vulpes*), Felids (*Felis* sp.), and Mustelids (*Martes* cf. *foina*) are represented by few skeletal elements in the upper level from Eynan. The distribution of these species varies between the samples, with higher frequencies in the stony layer (13% of the total NISP versus 6% in the structures). This could be related to sample size and to the fact that rare species appear more stochastically. Among the carnivores, the red fox is the most “abundant species” and is represented in every sample, whereas the stone marten is only documented in the stone layer sample and the felids in two structures (cf. table 2, fig. 14).

Hare (*Lepus capensis*) is the second (203, stony layer) or third most abundant species (200), accounting for 18-21% of the identified mammalian remains (cf. table 2). Hare bones from juveniles were found in the structure samples, suggesting a random predation of the species. In the stony layer, most of the hare bones present with fused epiphyses (Valla *et al.* 2004).

Stiner (2001) has suggested that, when present, small species may provide a better indicator for shifts in faunal exploitation patterns because they are more sensitive to changes in hunting/gathering techniques employed in their capture. For example the more intensive exploitation of hare during the Natufian compared to pre-and post Natufian periods may be due to the emergence of new gathering techniques such as the use of traps or nets (Bar-El, Tchernov 2001).

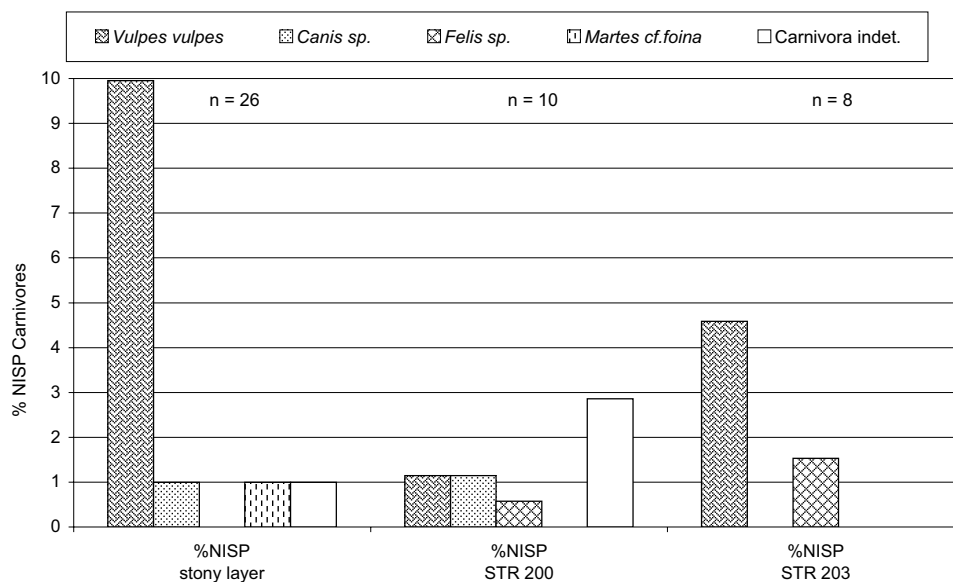


Fig. 14—Relative frequencies of the carnivore species in three assemblages from level Ib1.

REPRESENTATION OF HABITATS INFERRED FROM AVIFAUNA

Birds remains are an important component of the Eynan fauna (representing half of the identified vertebrate bones). The special location of the site, near a lake, had a major influence on the bird species composition. The bird remains studied by Simmons from the Ib1 (Simmons *in* Valla *et al.* 2004) are distributed among 10 families and 17 taxa. Over half the avian species found in the site prefer aquatic or shoreline habitats, forest and open field species account for approximately another 30% while only very few species prefer desert or rocky habitats (fig. 15).

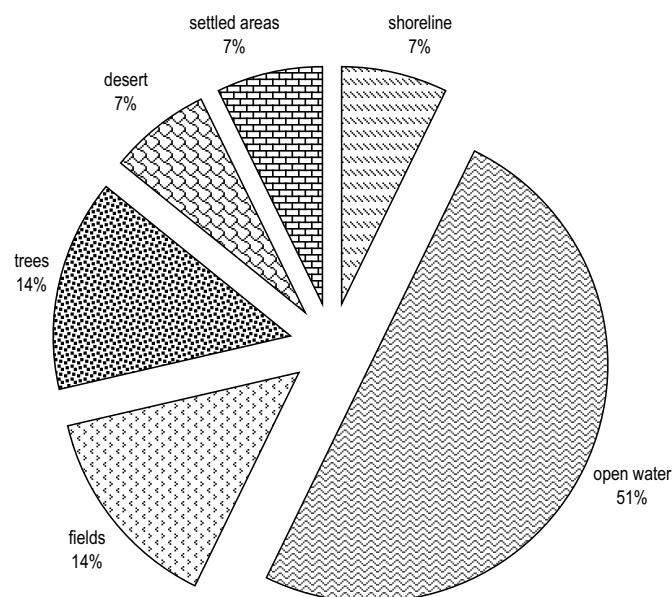


Fig. 15—Relative frequencies of the bird species from level Ib1.

The rarity ($n = 2$ in structure 203) of chukar partridge (*Alectoris chukar*), usually a common species in the Natufian assemblages (Pichon 1984; Munro 2001), should be noted. Probably, this species was simply less common in the immediate surroundings of Eynan due to habitat differences compared to other sites with access to greater expanses of the drier land, preferred by the chukar. In any event, the aquatic environs of the site had a marked impact on the exploited avifauna. With the exception of three resident species (*Falco tinnunculus*, *Alectoris chukar* and *Bubo bubo*), most of the species of Ib1 are wintering species, arriving in Israel in autumn and departing again during the spring.

As at other Natufian sites (Hatoula, Hayonim Cave, El Wad, etc.), the local avifauna was readily exploited. Since we are dealing with an open-air site, the presence of specific birds is more likely to be connected with the collector, in this case, most probably a human agency.

Moreover, as at most Natufian sites, the wing and breast meat elements are most commonly represented (*ca* 87% of all skeletal elements identified, predominantly from waterfowl), thus, presence of these elements is regarded as an indication of human processing and preference (Tchernov 1994). Birds of prey are only represented by a few terminal phalanges (*e.g.*, stony layer and structure 200). This pattern is likely to relate to an intentional differential selection of certain body parts by species (Tchernov 1994). This also reflects a continued cultural preference for using talons and, to a somewhat lesser degree at Eynan, flight feathers from birds of prey (both nocturnal and diurnal) for personal adornment (Simmons, Nadel 1998; Simmons 2002, 2004; Horwitz *et al.* in press).

BROADENING AND DIVERSIFYING THE PREY SPECTRUM

The relationship between environmental constraints, access to resources and foraging subsistence patterns has been widely debated. It has been highlighted that both predation on larger prey and dietary specialization go hand in hand with high group mobility, while broadening the prey spectrum makes it possible to decrease mobility, to reduce the foraging area or to shift subsistence strategy (*e.g.* Tchernov

1993b). Dietary broadening, diversification, and even exchange are also options to cope with a depletion of resources, either brief or caused by the intensity or duration of the site occupation (Halstead, O'Shea 1989; Bridault 1997).

The presence of a variety of habitats in the vicinity of Eynan probably offered the opportunity to trap, collect or simply gather a wide array of resources while walking, thus, reducing a search strategy that was inefficient and costly in terms of energy expenditures. Such modalities do not require particular technical skill, nor do they depend upon large-scale cooperation as in collective hunting, but rather a different division of tasks.

As revealed by the large variety of prey species, most of the trophic web was exploited at Eynan. The "high-ranking prey" (ungulates) and the "low-ranking prey" such as fast-moving ones (*e.g.* hare, waterfowl) and slow moving and easily collected species (*e.g.* tortoise, other reptile, shellfish) (Stiner 2001; Stiner *et al.* 2000) are all exploited. Quantifying the relative importance of the different types of "low-ranking prey" in order to measure human foraging efficiency as suggested by Munro (2003), could be misleading here. The heavy fragmentation of the material, the differential fragmentation between tortoise and most of the other vertebrate species skeletons and the very easy identification of tortoise remains (mainly carapace) make comparison of tortoise NISP frequencies with the other small vertebrate species problematic. The Eynan Final Natufian prey pattern appears very similar to that at other Late Natufian settlements. It was characterized by a change in the trophic level and a diversification towards some species that could either be exploited throughout the year or during certain critical periods (*i.e.* "buffering resources").

The diversified ungulate pattern evidenced at Eynan contrasts with the general predominance of gazelle in the Natufian. How can this be interpreted? Is this a reflection of a local or brief depletion of this resource caused by various factors such as long term hunting pressures (during Epipaleolithic) or as a shift in subsistence strategy or both? The question of a potential size decrease in gazelle at the Pleistocene-Holocene transition, related to environmental pressure (Davis 1983) and/or human hunting pressure (*e.g.* Horwitz *et al.* 1990; Cope 1991; Helmer 2000) also adds a piece to the puzzle. The assumption of a size decrease in gazelle due to intentional over-culling of males during the Natufian as argued by Cope (1991) should be tested for each site. Munro (2001) similarly proposed that, due to the low rates of population turnover and slow growth of gazelle populations, the impact of hunting pressure on their populations would be magnified. If this was the case then the proportion of juvenile gazelles should therefore increase as hunting pressures intensified. The present assemblages unfortunately do not permit a thorough examination of animal size, although the few measurable elements of fallow deer, gazelle, boar and hare indicate that these individuals may have been large body-sized representatives of these species (Rabinovich, Bridault *in Valla et al.* 2004). Evaluating the proportion of juveniles using the method of epiphyseal fusion has not proved accurate here because the proportion of immature gazelle is subject to differential bone preservation (few extremities and few immature bones); the method would then severely bias the results towards adults. However that may be, the other evidence for diversification is the abundance of wild boar. Wild boar is a species that adapts very readily to environmental change (*cf.* variations in birth distributions and size of the ranges), characterized by high population growth in a favorable environment ("r" strategy type, females may come into estrus several times per year; *e.g.* Sweeney *et al.* 1979; Bouldoire, Vassant 1989). Boar-hunting may then represent a very good candidate of a factor indicative of diversification in the economic strategy of the Eynan Final Natufian, with high returns and less risk of hunting pressure than on "k strategy" ungulates. Relying on several rather than on one high-ranking prey species is a risk-minimizing strategy.

A SEDENTARY FORAGING SOCIETY?

Seasonality data inferred from the season of death of the animals are one of the expected contributions to the characterization of the site occupation. Here we would like to shed light on several points concerning the nature of the data and the critical interpretation that remains to be carried out. Data gathered from the

occupation floors samples are theoretically the most relevant because they are assumed to correspond to a short time span. In practice it is necessary to take into account the main point: that the proportion of bone elements identifiable to species and moreover to age are very limited, due to the already discussed fragmentary nature of the faunal assemblage.

The assemblage from the upper floor of hut 203 has yielded bones of fetal boar and a fragment from an unshed roe deer antler. Thirty percent of the gazelle found in the upper floor of the “hut” 200 are immature individuals (2 months, 5-8 months and 10-18 month years old) including one fetus. Fallow deer remains come from animals aged 6-18 months and 2 years old. Wild boar remains, though not numerous and fragmented, provide indications of fetal or neo-nate animals. The faunal sample from the upper part of the stony layer has provided one fragment of unshed roe deer antler together with several unfused gazelle phalanges, indicating predation on animals younger than 5-8 months.

—The quality of the information gathered from the remains is heterogeneous: some indicators giving a larger interval of time (*i.e.*, data from the unshed roe deer antlers only allow the exclusion of the end of the fall season; wild boar fetus bones provide a time range of March-May, if a single farrowing peak is assumed).

—Some ungulates species may have one or several reproductive peaks per annum, depending on the conditions (for gazelle: Baharav 1983).

For instance, if the season for gazelle fawning is between March and June (one of the scenarios), then the yearling gazelle specimens from the sample of hut 200 reflect several seasons of death (May-August, August-January) with an overlap during August. Presence of fallow deer may indicate a hunt during April-July, while wild boar fetal bones may reflect a kill in the spring season. These kill-off patterns do not appear to be consistent with the autumn and winter period evidenced by the presence of some bird species. How can this dichotomy in species be interpreted? Does it mean that the site was occupied all year round but that a differential seasonal procurement strategy was practiced based on species availability or does it mean that the same site was occupied several times a year? Neither sedentism nor semi-sedentism can be ascertained based on such limited seasonality data, but they do hint at quite a prolonged period of occupation during the dry and wet season. Of course seasonality analyses need to take into account a maximum of indicators including faunal data (for instance including fish data—ongoing research by I. Zohar—or micromammals) together with other features such as architecture, industry, etc. (see Valla *et al.* 2004).

The presence of so-called commensal species such as the house mouse (*Mus musculus domesticus*) is generally related to sedentism even if “there is little agreement on the time-depth of human occupation required to facilitate commensal invasion” (Boyd 2006, p. 173). Tchernov pointed out the abrupt appearance of commensals (micromammals and some bird species) during the Natufian (Tchernov 1984, 1991, 1993a). Human sedentism creates new ecological niches, consequently colonized by anthropophilous species. Cucchi *et al.* (2005, p. 444) consider that the presence of domestic mouse is certain at Hayonim level B and it appears together with a feral mouse. Two species of mice are known in Cyprus, at the end of the 9th millennium BC: the house mouse, unintentionally brought by Neolithic immigrants and another non-commensal species. The latter species arrived on the island prior the house mouse, the result of accidental transportation by the first Epipaleolithic “hunters-gatherer-fishers” settlers (Cucchi *et al.* 2002; Bonhomme *et al.* 2004).

“Sedentary foraging” appeared in the Levant during the Early Natufian. Late Natufian people, whether sedentary or not, inherited a landscape already imprinted by an old cohabitation (even co-evolution) between humans and other species. Commensalism is not the only kind of relationship that may have existed during this period. At Eynan, another sign of this cohabitation is the importance of fox, an anthropogenic species (table 3). Following Tchernov, fox may be considered as a typically “synanthropic species that efficiently exploits human resources with almost no harm to the local inhabitants” (Tchernov 1994, p. 52). Consequently, the “high frequency of fox remains may reflect both this animal’s great abundance and long term activities around the site” (*ibid.*).

Sites	Rank	NISP Carnivores	References
Hayonim Terrasse, II	1	239	Munro 2004
Hilazon Tachitt	1	65	Munro 2004
Salibiya I	1	6	Crabtree <i>et al.</i> 1991
Mureybet Q32E2	1	48	Helmer 1991
Mureybet Q33B4	1	67	Helmer 1991
Mureybet Q33 B3	1	40	Helmer 1991
Eynan Ib1 Stony Layer	1	24	Rabinovich, Bridault, <i>in</i> Valla <i>et al.</i> 2004
Eynan Ib1 200	1	5	Rabinovich <i>in</i> Valla <i>et al.</i> 2001
Eynan Ib1203	1	8	Rabinovich <i>in</i> Valla <i>et al.</i> 2001

Table 3—Predominance of the fox among the carnivores (rank),
in various Late and Final Natufian assemblages.

CONCLUSION

Eynan appears to be a peculiar site if considered at the Natufian regional level. In terms of habitats exploited as revealed by the faunal spectrum it comprises a combination of typical Natufian exploitation of gazelle, combined with other available species such as boar, fallow deer, birds and fish. The special location of the site had a major impact on the species distribution because water was available throughout the year, a rare resource in the Mediterranean climate. If compared to other, later PPNA sites along the Jordan Valley (*e.g.* Gesher, Gilgal and Netiv Hagdud), gazelle is the most common species followed by pig, or aurochs (Tchernov 1994; Horwitz, Ashkenazi 2006; Horwitz *et al.* in press). Most of the faunal samples from the above-mentioned sites contain numerous birds (in most, birds represent more than 30% of the NISP, with the exception of Gesher).

Based on the data collected to date, hunting, gathering and fishing took place at Eynan, and it seems that medium-size mammals were the major dietary component. The extensive fragmentation and the broader taphonomic state of the fauna are as yet not understood. Is the fragmentation due to the intensity of the occupation at the site and therefore trampling of the food remains, or does it evidence a pattern of cleaning the huts, leaving only a small portion of the faunal remains *in situ*. Thus, this type of practice might have had a major influence on the interpretation of human activity at Eynan and may indicate that only a small portion of the faunal remains that have come to light are truly useful for analysis.

BIBLIOGRAPHY

- BAHARAV D. 1983, "Observation on the ecology of the Mountain Gazelle in the Upper Galilee, Israel", *Mammalia* 47, p. 59-69.
- BAR-EL T., TCHERNOV E. 2001, "Lagomorph remains at prehistoric sites in Israel and southern Sinai", *Paléorient* 26 (1), p. 93-109.
- BAR-MATTEWS M., AYALON A., KAUFMAN A. 1997, "Late Quaternary paleoclimate in the Eastern Mediterranean region from stable isotope analysis of speleotherms at Soreq cave, Israel", *Quaternary research* 47, p. 155-168.
- BAR-OS G., DAYAN T. 1999, "The Epipalaeolithic faunal sequence in Israel: a view from Neve David", *Journal of Archaeological Science* 26, p. 67-82.
- BAR-YOSEF O., BELFER-COHEN A. 2002, "Facing environmental crisis. Societal and cultural changes at the transition from the Younger Dryas to the Holocene in the Levant", in R.T.J. Cappers, S. Bottema (eds), *The Dawn of Farming in the Near East, Studies in Early Near Eastern Production, Subsistence, and Environment* 6, Ex Oriente, Berlin, p. 55-66.
- BINFORD L.R. 1981, *Bones: Ancient Men and Modern Myths*, Academic Press, New York.
- BONHOMME F., ORTH A., CUCCHI T., HADJISTERKOTIS E., VIGNE J.-D., AUFRAY J.-C. 2004, "Découverte d'une nouvelle espèce de souris sur l'île de Chypre", *CR Biologies* 327, p. 501-507.
- BOULDOIRE J.-L., VASSANT J. 1989, *Le sanglier*, Hatier, Paris.
- BOYD B. 2006, "On 'sedentism' in the Later Epipalaeolithic (Natufian) Levant", *World Archaeology* 38 (2), p. 164-178.
- BRAIN C. K. 1981, *The Hunters or the Hunted? An Introduction to African Cave Taphonomy*, The University of Chicago Press, Chicago.
- BRIDAULT A. 1997, "Broadening and diversification of hunted resources, from the Late Palaeolithic to the Late Mesolithic, in the North and East of France and the bordering areas", *Anthropozoologica* 25-26, Proceedings of the 7th international Conference for Archaeozoology, ICAZ, Constance, sept. 1994, p. 295-308.
- BRIDAULT A., CHAIX L. 1998, "Contribution de l'archéozoologie à la caractérisation des modalités d'occupation des sites alpins et jurassiens, de l'Épipaléolithique au Néolithique ancien", in A. Thévenin, P. Bintz (éds), *L'Europe des derniers chasseurs: Épipaléolithique et Mésolithique*, CTHS, Paris, p. 547-558.
- CLASON A.T., PRUMMEL W. 1977, "Collecting, sieving and archaeozoological research", *Journal of Archaeological Science* 4, p. 171-175.
- CRABTREE P.J., CAMPANA D.V., BELFER-COHEN A., BAR-YOSEF D. 1991, "First results of the excavations at Salibiya I, lower Jordan Valley", in O. Bar-Yosef, F.R. Valla (eds), *The Natufian Culture in the Levant*, Ann Arbor, Michigan, International Monographs in Prehistory (Archaeological Series 1), p. 161-172.
- COPE R.C. 1991, "Gazelle hunting strategies in the southern Levant", in O. Bar-Yosef, F.R. Valla (eds), *The Natufian Culture in the Levant*, Ann Arbor, Michigan, International Monographs in Prehistory (Archaeological Series 1), p. 341-357.
- CUCCHI T., VIGNE J.-D., AUFRAY J.-C., CROFT P., PELTENBURG E. 2002, "Introduction involontaire de la souris domestique (*Mus musculus domesticus*) à Chypre dès le Néolithique ancien (fin IX^e et VIII^e millénaires av. J.-C.)", *CR Palévol* 1, p. 235-241.
- CUCCHI T., VIGNE J.-D., AUFRAY J.-C. 2005, "First occurrence of the house mouse (*Mus musculus domesticus* Schwartz and Schwartz 1943) in Western Mediterranean: a zooarchaeological revision of sub-fossil house mouse occurrences", *Biological Journal of the Linnean Society* 84, p. 429-445.
- DAVIS S. 1981, "The effects of temperature change and domestication on the body size of Late Pleistocene to Holocene mammals of Israel", *Paleobiology* 7 (1), p. 101-114.
- DAVIS S. 1982, "Climate change and the advent of domestication: the succession of ruminant

- artiodactyls in the Late Pleistocene-Holocene period in the Israel region", *Paléorient* 8 (2), p. 2-16.
- DAVIS S. 1985, "A preliminary report of the fauna from Hatoula: a Natufian-Khiamian (PPNA) site near Latroun, Israel", in M. Lechevallier, A. Ronen (eds), *Le Site Natoufien-Khiamien de Hatoula*, Cahiers du CNRF 1, Association Paléorient, Paris, p. 71-98.
- DIMENTMAN C., BROMLEY H.J., POR F.D. 1992, *Lake Hula: Reconstruction of the Fauna and Hydrobiology of a Lost Lake*, Jerusalem, The Israel Academy of Sciences and Humanities.
- DUCOS P. 1973, "La signification de quelques paramètres statistiques utilisés en paléthnozoologie", in M. Sauter (éd.), *L'Homme, hier et aujourd'hui. Recueil d'études en hommage à A. Leroi-Gourhan*, Cujas, Paris, p. 307-313.
- FLANNERY K.V. 1969, "Origins and ecological effects of early domestication in Iran and the Near East", in P.J. Ucko, G.W. Dimpleby (eds), *The Domestication and Exploitation of Plants and Animals*, Adline, Chicago, p. 73-100.
- GORING-MORRIS N.A., BELFER-COHEN A. 1998, "The articulation of cultural processes and late Quaternary environmental changes in Cisjordan", *Paléorient* 23, p. 71-93.
- GVIRTZMAN G., WIEDER M. 2001, "Climate of the 53,000 years in the eastern Mediterranean, based on soil-sequence stratigraphy in the coastal plain of Israel", *Quaternary Science Reviews* 20, p. 1827-1849.
- HALSTEAD P., O'SHEA J. 1989, "Introduction: Cultural responses to risk and uncertainty", in P. Halstead, J. O'Shea (eds), *Bad Year Economics: Cultural Responses to Risk and Uncertainty*, Cambridge University Press, Cambridge, p. 1-7.
- HELMER D. 1991, "Étude de la Faune de la Phase 1a (Natoufien final) de Tell Mureybet (Syrie), Fouilles Cauvin", in O. Bar-Yosef, F.R. Valla (eds), *The Natufian Culture in the Levant*, International Monographs in Prehistory, Ann Arbor, Michigan, p. 359-370.
- HELMER D. 2000, "Étude de la faune mammalienne d'El Kowm 2", in D. Stordeur (ed.), *El Kowm 2. Une Ile dans le désert: la fin du Néolithique Précéramique dans la steppe syrienne*, CNRS Éditions, Paris, p. 233-264.
- HORWITZ L.K., COPE C., TCHERNOV E. 1990, "Sexing the bones from mountain-gazelle (*Gazella gazella*) from prehistoric sites in the southern Levant", *Paléorient* 16 (2), p. 1-12.
- HORWITZ L.K., ASHKENAZI S. 2006, "The fauna", in Y. Garfinkel, D. Dag (eds), *Gesher: A PPNA Site in the Central Jordan Valley, Israel*, Ex Oriente, Berlin, p. 159-173.
- HORWITZ L.K., SIMMONS T., LERNAU O., TCHERNOV E. in press, "Fauna from the sites of Gilgal I-III", in O. Bar-Yosef, A. Gopher, N. Goring-Morris (eds), *The Epipaleolithic and Early Holocene Site Complex of Gilgal, Israel*, Peabody Museum Publications, Brill.
- MUNRO N. 2001, *A Prelude to Agriculture: Game Use and Occupation Intensity During the Natufian Period in the Levant*, Unpublished Ph.D. Dissertation, University of Arizona, Tucson, AZ.
- MUNRO N. 2003, "Small game, the younger Dryas and the transition to agriculture in the southern Levant", *Mitteilungen der Gesellschaft für Urgeschichte* 12, p. 47-71.
- MUNRO N. 2004, "Zooarchaeological measures of hunting pressure and occupation intensity in the Natufian, Implications for agricultural origins", *Current Anthropology* 45, p. 5-33.
- MUNRO N., BAR-OZ G. 2005, "Gazelle fat bone processing in the Levantine Epipalaeolithic", *Journal of Archaeological Science* 32 (2), p. 223-239.
- NOY T., LEGGE A.J., HIGGS E.S. with a contribution by DENNELL R.W. 1973, "Recent excavations at Nahal Oren, Israel", *Proceedings of the Prehistoric Society* 39, p. 75-99.
- PAYNE S. 1975, "Partial recovery and sample bias", in A.T. Clason (ed.), *Archaeozoological Studies*, American Elsevier, New York, p. 7-17.
- PICHON J. 1984, *L'avifaune natoufienne du Levant. Systématique, Paléoécologie, Paléothnozoologie*, Thèse de 3^e cycle (unpublished dissertation), Université Pierre et Marie Curie, Paris.

- SAMUELIAN N., KHALAILY H., VALLA F.R. 2006, "Final Natufian architecture at Eynan (Ain Mallaha). Approaching the diversity behind uniformity", in E.B. Banning, M. Chazan (eds), *Domesticating Space*, Ex Oriente, Berlin, p. 35-42.
- SIMMONS T. 2002, "The birds of Ohalo II", in D. Nadel (ed.), *Ohalo II: A 23,000-Year-Old Fisher-Hunter-Gatherers' Camp on the shore of the Sea of Galilee*, Reuben and Edith Hecht Museum, University of Haifa, Hebrew p. 29-32; English p. 32-36.
- SIMMONS T. 2004, "A feather for each wind that blows": utilizing avifauna in assessing changing patterns in palaeoecology and subsistence at Jordan Valley archaeological sites", in N. Goren-Inbar, J. Speth (eds), *Human Palaeoecology in the Levantine Corridor*, Chapter XIII, Oxbow Books, Oxford, p. 91-205.
- SIMMONS T., NADEL D. 1998, "The avifauna of the Early Epipalaeolithic Site of Ohalo II (19,400 BP), Israel: species diversity, habitat, and seasonality", *International Journal of Osteoarchaeology* 8, p. 79-96.
- STINER M.C. 2001, "Thirty years on the 'Broad Spectrum Revolution' and Paleolithic demography", *Proceedings of the National American Science* 98 (13), p. 6993-6996.
- STINER M.C., MUNRO N.D., SUROVELL T.A., TCHERNOV E., BAR-YOSEF O. 1999, "Paleolithic population growth pulses evidenced by small animal exploitation", *Science* 283, p. 190-194.
- STINER M.C., MUNRO N.D., SUROVELL T.A. 2000, "The tortoise and the hare. Small-game use, the broad-spectrum revolution, and Paleolithic demography", *Current Anthropology* 41, p. 39-73.
- SWEENEY J.M., SWEENEY J.R., PROVOST E.E. 1979, "Reproductive biology of a feral hog population", *Journal of Wildlife Management* 43 (2), p. 555-559.
- TCHERNOV E. 1984, "Commensal animals and human sedentism in the Middle East", in J. Clutton-Brock, C. Grigson (eds), *Animals and Archaeology. 3: Early Herders and Their Flocks*, BAR International Series 202, Oxford, p. 91-115.
- TCHERNOV E. 1991, "Of mice and men. Biological markers for long-term sedentism. A reply", *Paléorient* 17 (1), p. 153-160.
- TCHERNOV E. 1993a, "From sedentism to domestication —a preliminary review for the southern Levant", in A.-T. Clason, S. Payne, H.P. Uerpmann (eds), *Skeletons in her Cupboard: Festschrift for Juliet Clutton-Brock*, Oxbow, Monograph 34, p. 89-217.
- TCHERNOV E. 1993b, "The effects of sedentism on the exploitation of the environment in the Southern Levant", in J. Desse, F. Audoin-Rouzeau (eds), *Exploitation des animaux sauvages à travers le temps* (XII^e rencontres Internationales d'Archéologie et d'Histoire d'Antibes), ADPCA, Juan-Les-Pins, p. 137-159.
- TCHERNOV E. 1994, *An Early Neolithic village in the Jordan valley. Part II: The Fauna of Netiv Hagdud*. Peabody Museum of Archaeology and Ethnology (American school of prehistoric research, 44), Cambridge MA.
- TCHERNOV E. 1998, "An attempt to synchronise the faunal changes with the radiometric dates and cultural chronology in Southwest Asia", in H. Buitenhuis, L. Bartosiewicz, A.M. Choyke (eds), *Archaeozoology of the Near East III*, ARC-Publicaties 18, Groningen, p. 7-44.
- VALLA F.R. 1988, "La fin de l'Épipaléolithique au Levant : les industries à microlithes géométriques", *L'Anthropologie* 92 (3), p. 901-925.
- VALLA F.R., SAMUELIAN N., BOCQUENTIN F., DELAGE C., VALENTIN B., PLISSON H., RABINOVICH R., BELFER-COHEN A. 1999, "Le Natoufien final et les nouvelles fouilles à Mallaha (Eynan), Israel, 1996-1997", *Journal of the Israel Prehistoric Society* 28, p. 105-176.
- VALLA F.R., KHALAILY H., SAMUELIAN N., BOCQUENTIN F., DELAGE C., VALENTIN B., PLISSON H., RABINOVICH R., BELFER-COHEN A. 2001, "Le Natoufien final de Mallaha (Eynan), deuxième rapport préliminaire : la fouille de 1998 et 1999", *Journal of the Israel Prehistoric Society* 31, p. 43-184.
- VALLA F.R., KHALAILY H., VALLADAS H., TINERAT-LABORDE N., SAMUELIAN N., BOCQUENTIN F., RABINOVICH R., BRIDAULT A., SIMMONS T., Le DOSSEUR G., MILLER-ROSEN A., DUBREUIL L., BAR-YOSEF-MAYER D., BELFER-COHEN A. 2004, "Les fouilles à Mallaha en 2000 et 2001 : 3^e rapport préliminaire", *Journal of the Israel Prehistoric Society* 33, p. 75-205.